



Using NASA's Reference Architecture: Comparing Polar and Geostationary Data Processing Systems

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Introduction



- The JPSS and GOES-R programs are housed at NASA GSFC and jointly implemented by NASA and NOAA to NOAA requirements. NASA's role in the JPSS Ground System is to develop and deploy the system according to NOAA requirements. NASA's role in the GOES-R ground segment is to provide Systems Engineering expertise and oversight for NOAA's development and deployment of the system.
- NASA's Earth Science Data Systems Reference Architecture is a document developed by NASA's Earth Science Data Systems Standards Process Group that describes a NASA Earth Observing Mission Ground system as a generic abstraction.
- The authors work within the respective ground segment projects and are also separately contributors to the Reference Architecture document. Opinions expressed are the author's only and are not NOAA, NASA or the Ground Projects' official positions.



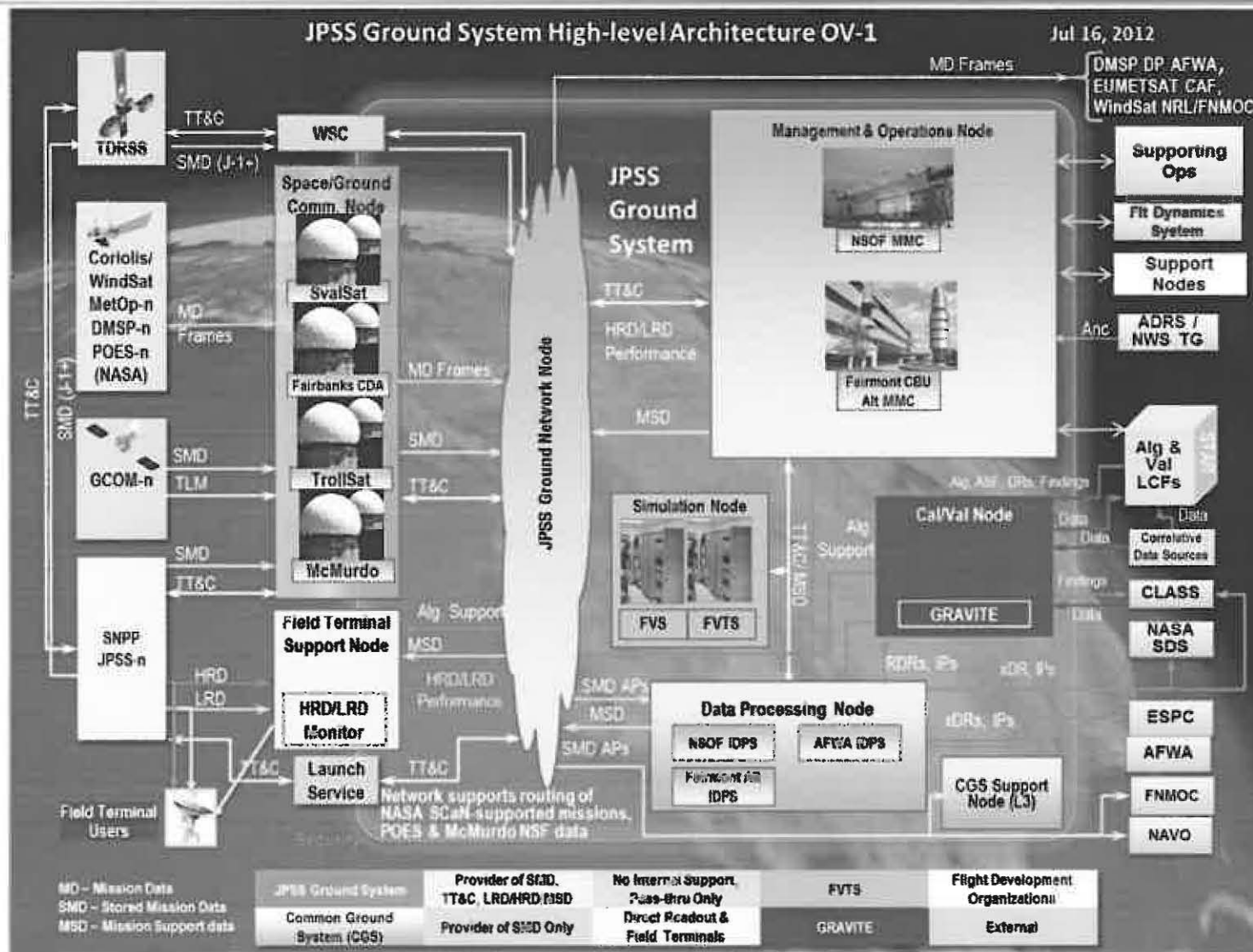
NASA's ESDS Reference Architecture



- Source
 - NASA's Earth Science Data Systems Working Group (ESDSWG) Standard Process Group (SPG)
 - "ESDS Reference Architecture for the Decadal Survey Era"
 - A data model, a set of functions and services that are common among data systems that operate on NASA's Earth Science data
 - Provides individuals and teams with a concrete strategy for the development and implementation of higher-level design.
- Intent of the Reference Architecture
 - Establish a common "language" to describe the problem- and solution-space of NASA's Earth Science Data Systems
- Approach
 - Define "Reference Architecture" and its role/usage
 - Identify Stakeholders
 - Establish basis of the problem
 - Regular vetting within NASA's ESDS community
 - Conduct a workshop, collect feedback

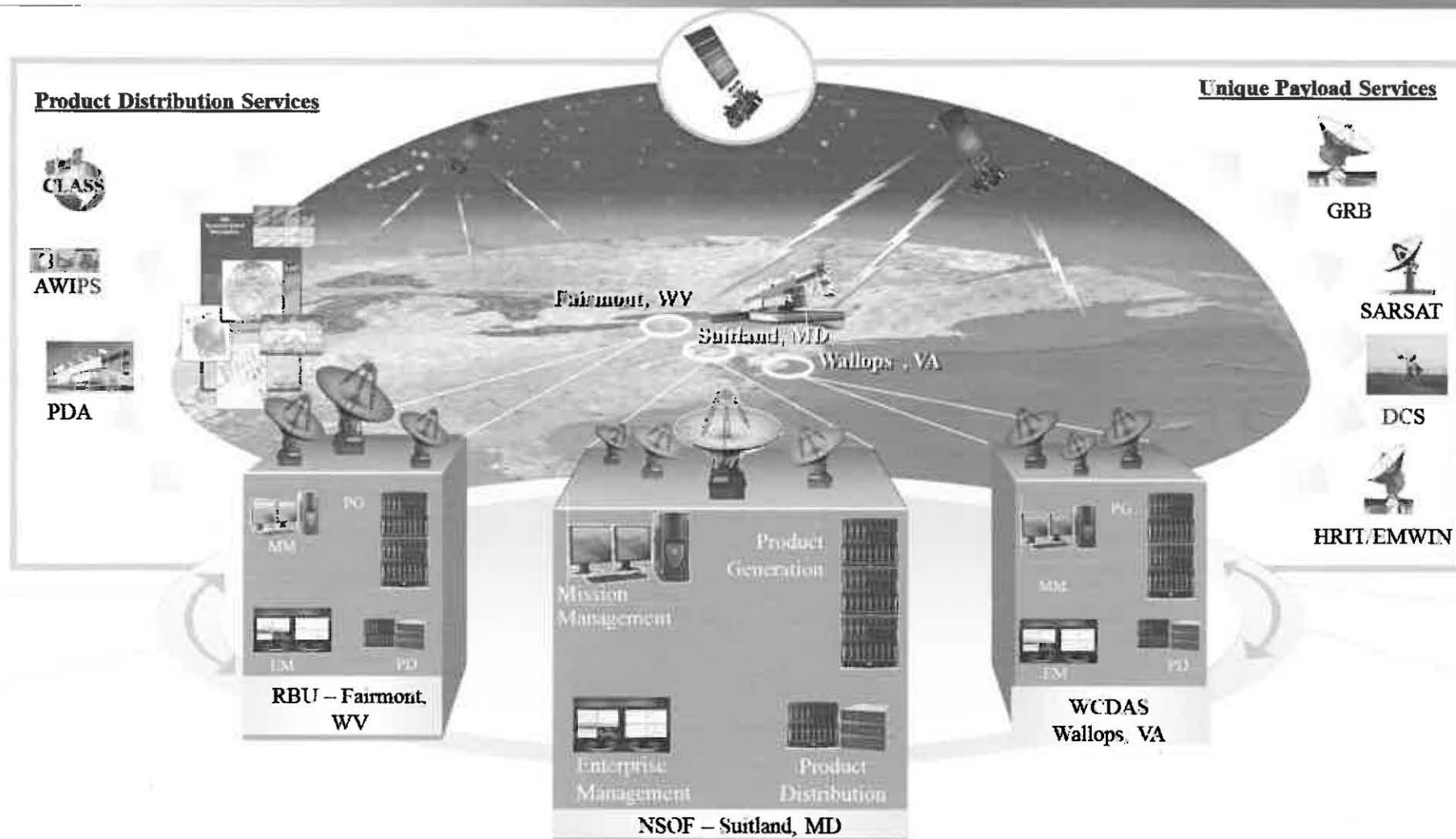


JPSS Ground System Architecture





GOES-R Architecture



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Reference Architecture Overview



- **Drivers**
 - SPG Efforts (Identify common components, interfaces among components and standards)
 - Build a common understanding of NASA's ESDS's
 - Decadal Survey Missions
 - Interoperability momentum within NASA
- **Six High-level Use Cases (Business Use Cases)**
 - Six High-level (Business Use Cases)
 - Receive Sensor Data
 - Develop Products
 - Distribute products
 - Develop Predictions
 - Manage Remote Sensor/Instrument
 - Data Stewardship
- **Views**
 - Functional View
 - Information View
 - System Service View
 - Technology View
- **Mappings between views (as appropriate)**



Contrasting Polar and Geostationary



- The obvious
 - Science products similar (sensor physics, Earth physics, science)
 - Product, Spatial Extent, geometry, resolution differences.
 - Constellations are different, orbit, communications, etc.
 - Data Collection Ground Sites (polar international, versus temperate domestic)
 - Delivery of data to those sites (constant v. episodic bursty)
 - Production work flow rules similar (dependencies, triggers, timeliness)
 - Communications and computer technology (same state of art).
- Effects on Ground and Data Systems
 - Facilities divergence (sites)
 - Networking divergence, (sites, peaks)
 - Product pipeline differences (product queuing, geometric/geographic relationships among granules)
 - Capacities
 - Latency differences due to practical limitations and use cases



Reference Architecture Use Cases



- The NASA ESDS reference architecture has identified a set of mission-level use cases that represent the common scope of all NASA ESDS's.
- NOAA's JPSS and GOES-R observatory ground data processing systems both share the ESDS use cases.

ESDS	ESDS Name	Description	System Architect
ESDS-1	Receive Sensor Data	Receive sensor data from sensors to be used for processing	System Architect Data Architect Project Scientist Data Scientist
ESDS-2	Develop Products	Using algorithms and other services, data is transformed into higher value products	System Architect Data Architect Project Scientist Data Scientist Program Management
ESDS-3	Distribute Products	Generated products are made available to end users. This includes the decision and analysis of data usage, as well as the actual delivery of data to end users	System Architect Data Architect Data Scientist Program Management
ESDS-4	Develop Predictions	Using data products and models, predictions are generated. These are used to provide information to the users about the way they use data products	System Architect Data Architect Program Management Policy Management
ESDS-5	Manage Remote Sensor/Instrument	The control and management of remote sensing instruments	System Architect Project Scientist Program Management Data Management
ESDS-6	Data Stewardship	Raw data is processed and available for use by the user (processed sensor data)	System Architect Data Architect Data Scientist Data Management

Similarities

- Distribute products
 - GOES-R and JPSS have substantially similar customers for product distribution.
- Develop Predictions *(not applicable)
 - The NOAA observatory ground systems are responsible for reporting observations and not for developing predictions, but observations produced *do* feed predictions
- Manage Remote Sensor/Instrument
 - While every instrument and observatory is different the work flows for managing them are substantially similar between JPSS and GOES-R.
- Data Stewardship *(not applicable)
 - The NOAA observatory ground systems are not directly responsible for long-term stewardship, but rather are producers serving the same CLASS archive system

Differences

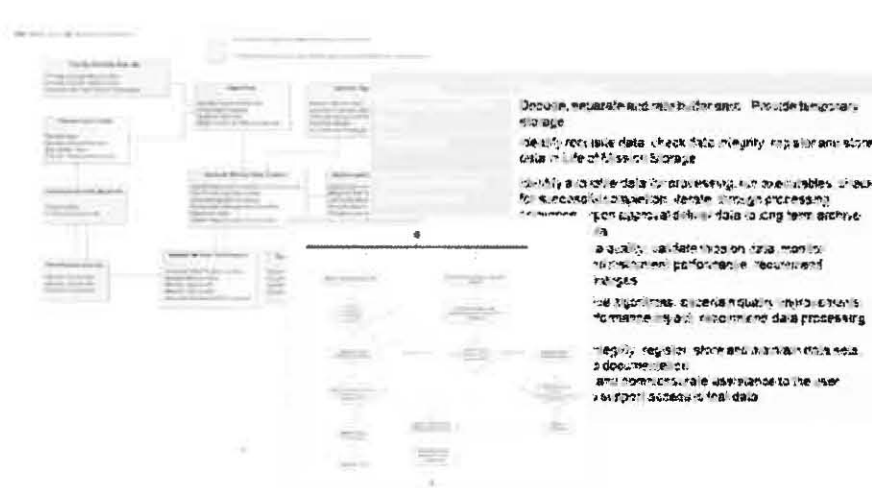
- Receive Sensor Data
 - The location of ground stations and the technology for receipt are significantly different and require completely separate infrastructure and communications routing
 - Direct Broadcast and GOES Rebroadcast respectively are dissimilar, driving different antenna design and data use cases.
- Develop Products
 - While environmental products are similar, the geometry of observation and the streaming and queuing of raw data are considerably different. These differences may drive different optimizations within the production system.



Reference Architecture Functional View



- The Functional View is intended to identify those high-level functions that are supported by systems that implement the reference architecture. The functions identified within the Functional View are intended to be comprehensive in that they cover all the functions that a fully capable instance of the reference architecture will offer.



Similarities

- The functions identified exist in both GOES-R and JPSS Ground systems
 - Process Level Zero Data
 - Ingest Data
 - Generate Mission Data Products
 - Monitor Mission Performance
 - Enhance Processing Algorithms
 - Archive Data
 - Distribute Data

Differences

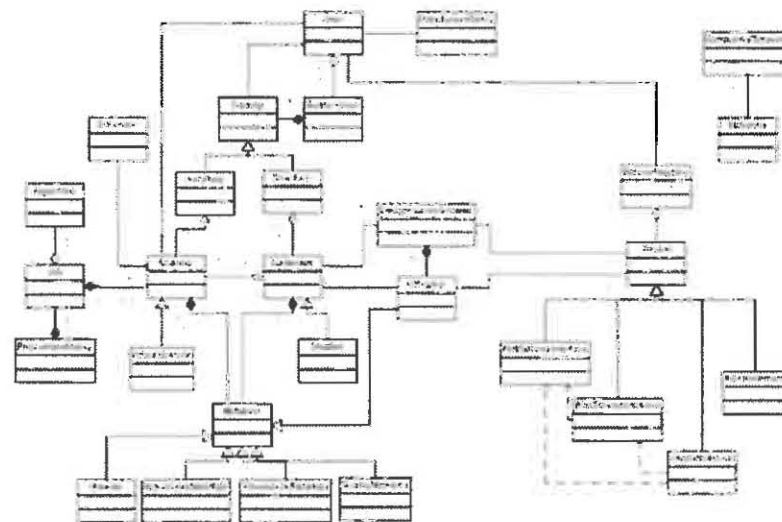
- Current JPSS and GOES-R implementations vary in their implementation details: Data format, metadata models, interfaces, delegation of functions to components, etc.



Reference Architecture Information Architecture View



- The Information Architecture View is intended to identify the high level information entities that are implemented within, and exchanged between systems that implement the reference architecture. It also defines the relationships between those information entities.



Similarities

- JPSS and GOES-R Ground Projects share a common information view. Though neither implements all elements, the subset of elements between them is similar.
- The NOAA information architecture emphasizes institutional use cases that differ somewhat from those emphasized by NASA. In particular, NOAA's first-class user is the focused on observational application use and prediction systems, while NASA's is focused on researcher access.

Differences

- JPSS information architecture requirements were set in FGDC content standard and were influenced by multiple agencies without a common encoding standard. Implementation was completed before 2005 with design predating wide adoption of ISO standards.
- GOES-R information architecture requirements were fully informed by NASA EOS experience with FGDC content and EOS encoding; NESDIS experience with netCDF3, COARDS and CF conventions; and the OAIS reference model. Design and implementation of the GOES-R Metadata Model (GMM) is ongoing and strongly influenced by published ISO standards.



Reference Architecture System Service View



- The System Service View of the ESDS Reference Architecture is intended to identify the key system-level services that are implemented within ESDS's. This representation is based on the Service-Oriented architecture pattern.

Service Name	Service Description
Authentication	Provides authentication services for system users and applications.
Authorization	Provides authorization services for system users and applications.
Configuration	Provides configuration services for system users and applications.
Discovery	Provides discovery services for system users and applications.
Logging	Provides logging services for system users and applications.
Monitoring	Provides monitoring services for system users and applications.
Notification	Provides notification services for system users and applications.
Reporting	Provides reporting services for system users and applications.
Storage	Provides storage services for system users and applications.
Transfer	Provides transfer services for system users and applications.
Validation	Provides validation services for system users and applications.

Similarities

- In general, these services are common between JPSS and GOES-R ground systems.
- Both systems leverage other enterprise systems to provide some of the services (e.g – ESPDS and CLASS for access, discovery and subscription)

Differences:

- BroadcastData carries data at differing process levels. (observation vs. Level1b)
- GOES-R leveraging ESPDS for security-oriented services
- JPSS data to ESPDA through NDE
- Implementations & interfaces

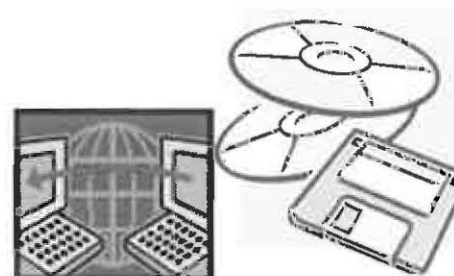


Reference Architecture Technology View



- The Technology View of the ESDS Reference Architecture provides guidance on the role and selection of technologies and standards. [However], the lifecycle of technologies and standards is not easily congruent with any Reference Architecture.

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Similarities:

- GOES-R and JPSS Ground systems share the same needs for technologies and standards as outlined in the reference architecture.
- Generally both systems have been driven by the state of the art in communication signal processing, r/f link management, networking, computer hardware and software practices.

Differences:

- The two ground systems have been developed without specific regard for the choices one or the other has made.
- Different standards or vendors were chosen based on engineering judgment, preferences or pricing.



Next Steps



- **Given significant overlap in the problem-space**
 - Conduct detailed analysis of the JPSS and GOES-R solutions
 - How they leverage NOAA enterprise-level services
 - Opportunities for common interfaces
 - Software and Human
 - Adaptors and/or Facades
 - Operational impacts
 - Leveraging common standards
 - Identify opportunities for new standards
- **For the evolving enterprises**
 - Recommended approaches to maximize commonality
 - Isolate and clarify appropriate differences
 - Opportunities for efficiency of programs and investments
- **Provide feedback to NASA's ESDS Reference Architecture**



References



- <http://earthdata.nasa.gov/our-community/esdswg/standards-process-spg/spgfolder/nasa-esds-reference-architecture-v11>